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Build isolated power supply based on capacitors

Use capacitors, instead of a transformer, to get an isolated supply source

By Chris Cokayne and Ben Wolde

Isolated power is usually generated with a transformer, but it can also be generated using capacitors. For some systems, the constraints of size and cost may favor capacitors.

In **Figure 1**, the IC (MAX256) is an integrated primary-side controller and H-bridge driver for isolated power-supply circuits.

Its oscillator, protection circuitry and internal FET drivers usually provide up to 3 watts of power to the primary winding of a transformer. In this case, the device drives a pair of capacitors that substitute for the transformer in providing isolation and power transfer.

The IC's adjustable switching frequency (100 kHz to 1 MHz) allows the use of small isolation capacitors, as illustrated below by an equation giving the capacitor impedance at 1 MHz. Losses are negligible at low output power:

$$X_c=1/2\pi fC=1/(2*3.14*10^6*0.45*10^{-6})\cong 0.35\Omega.$$

Complementary square-wave drive signals from the IC (ST1 and ST2) are coupled by the isolation capacitors and full-wave rectified by the diodes to produce an isolated output voltage. The high switching frequency also allows use of a small output capacitor. Ignoring switching losses, the output voltage is:

$$V_{out}=V_{in}-2V_{cap}-2V_{diode},\ \text{where}\ V_{cap}=I_{out}*X_c.$$

Assuming I_{out} = 500 mA, then:

$$V_{out}=5-2(0.5*0.35)-2(0.5)=5-0.35-1\cong 3.7\ \text{V}.$$

This circuit suits applications for which the potential difference across the isolation barrier is fixed. (Capacitors provide isolation at dc, but not for ac signals.) With the component values shown and a 500-mA load, ripple voltage is about 10 percent of the dc output level.

You can reduce this ripple by increasing the value of the output capacitor. Other circuit performance includes the power-up response with an 8Ω (~0.5 A) load **(Figure 2)**, the no-load power-up response **(Figure 3)** and the load-transient response obtained by connecting 8Ω to an unloaded output **(Figure 4)**. In the figures, Channel 3 is the +5-V supply (V_{CC}), and Channel 4 is the voltage across the output capacitor. ■

— The authors are with Maxim Integrated Products (Sunnyvale, Calif.).

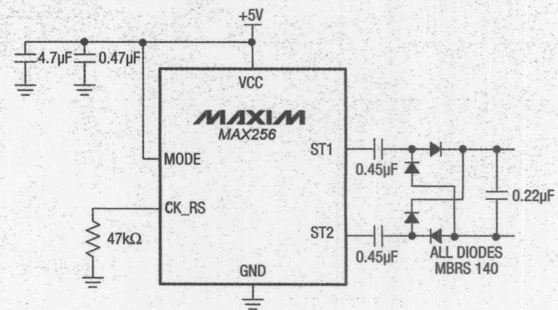

Figure 1
This simple circuit generates a capacitively isolated output voltage.

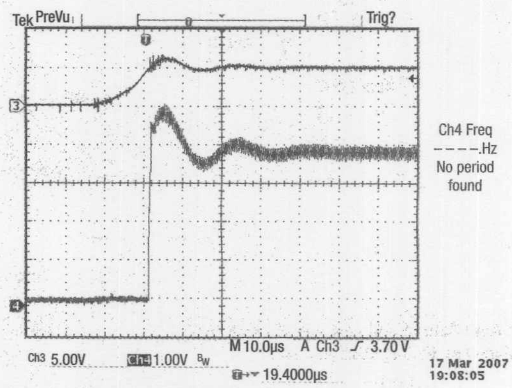

Figure 2
Power-up response of the Figure 1 circuit with 8Ω load.

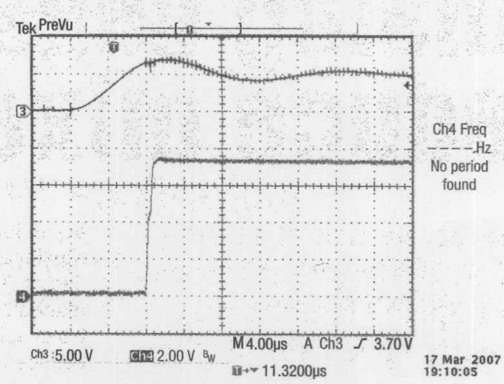

Figure 3
Power-up response of the Figure 1 circuit with no load.

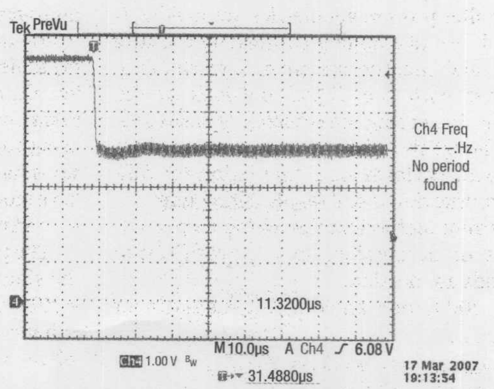

Figure 4
Load-transient response of the Figure 1 circuit, switching from no load to 8Ω load.